LOAN DOCUMENT

PHOTOGRAPH THIS SHEET

DTIC ACCESSION NUMBER

LEVEL

INVENTORY

Completion of One-Year Boventing...

DOCUMENT IDENTIFICATION

26 Sep 95

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

DISTRIBUTION STATEMENT

ACCESSION FOR
NTIS GRA&I
DTIC TRAC
UNANNOUNCED
JUSTIFICATION

BY

DISTRIBUTION/

AVAILABILITY CODES

DISTRIBUTION	AVAILABILITY AND/OR SPECIAL	
A-1		

DISTRIBUTION STAMP

DATE ACCESSIONED

DATE RETURNED

20010116 033

DATE RECEIVED IN DTIC

REGISTERED OR CERTIFIED NUMBER

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-FDAC

HANDLE WITH CARE

DTIC FORM 70A JUN 90

DOCUMENT PROCESSING SHEET

PREVIOUS EDITIONS MAY BE USED UNTIL STOCK IS EXHAUSTED.

LOAN DOCUMENT

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AIR FORCE BASE TEXAS

26 September 1995

MEMORANDUM FOR 730 CES/CEVR (Mr. Yamauchi)
1172 Iceland Avenue
Vandenberg AFB, CA 93437-6011

FROM: HQ AFCEE/ERT
8001 Arnold Drive
Brooks AFB TX 78235-5357

SUBJECT: Completion of One-Year Bioventing Test, Vandenberg AFB BX Service Station and Facility 6454

The Air Force Center for Environmental Excellence (AFCEE) one-year bioventing test and evaluation projects at the BX Service Station and Facility 6454 have been completed. For each site, Figure 1 provides general site information and Table 1 provides a summary of initial, six-month, and one-year fuel biodegradation rates measured at several monitoring points. Table 2 provides a summary of initial and final soil and soil gas sampling results for total recoverable petroleum hydrocarbons (TRPH) and BTEX. Based on results from your two sites and 123 other sites currently under operation, bioventing is cost-effectively remediating fuel contamination in a reasonable time-frame. We recommend its application throughout the Air Force and at other sites on your installation using the criteria in the AFCEE Test Plan and Technical Protocol for a Field Treatability Test for Bioventing, May 1992, including Addendum One, February, 1994. These are found in the "Tool Box" recently sent to your base.

The objective of the one-year sampling effort was not to collect the large number of samples required for statistical significance, but to show relative changes in TRPH and BTEX concentrations. Soil gas sampling results at the BX Service Station indicate more than three orders of magnitude reduction in TVH and BTEX at BXS-MW-7. Soil gas sampling at the other two locations was not possible due to high groundwater levels. Soil concentrations of TRPH and BTEX decreased by an order of magnitude at all monitoring points. Gasoline range total petroleum hydrocarbons were nondetect after one year of treatment. For additional soil sampling information, consult the U.S. Bureau of Reclamation who collected samples before system start-up at the BX Service Station and after 1 year of treatment. This data indicates up to 4 orders of magnitude decrease in TPH concentrations.

AQ M01-04-0621

DEFENSE TECHNICAL INFORMATION CENTER
REQUEST FOR SCIENTIFIC AND TECHNICAL REPORTS

Title: AFCEE Collection

1. Report Availability *(Please check one box)*

☒ This report is available. *Complete sections 2a - 2f.*

☐ This report is not available. *Complete section 3.*

2a. Number of Copies Forwarded: 1 each

2b. Forwarding Date: July/2000

2c. Distribution Statement *(Please check ONE box)*

DoD Directive 5230.24, "Distribution Statements on Technical Documents," 18 Mar 87, contains seven distribution statements, as described briefly below. Technical documents MUST be assigned a distribution statement.

☒ DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited.

☐ DISTRIBUTION STATEMENT B: Distribution authorized to U.S. Government Agencies only.

☐ DISTRIBUTION STATEMENT C: Distribution authorized to U.S. Government Agencies and their contractors.

☐ DISTRIBUTION STATEMENT D: Distribution authorized to U.S. Department of Defense (DoD) and U.S. DoD contractors only.

☐ DISTRIBUTION STATEMENT E: Distribution authorized to U.S. Department of Defense (DoD) components only.

☐ DISTRIBUTION STATEMENT F: Further dissemination only as directed by the controlling DoD office indicated below or by higher authority.

☐ DISTRIBUTION STATEMENT X: Distribution authorized to U.S. Government agencies and private individuals or enterprises eligible to obtain export-controlled technical data in accordance with DoD Directive 5230.25, Withholding of Unclassified Technical Data from Public Disclosure, 6 Nov 84.

2d. Reason For the Above Distribution Statement *(in accordance with DoD Directive 5230.24)*

2e. Controlling Office: HQ AFCEE

2f. Date of Distribution Statement Determination: 15 Nov 2000

3. This report is NOT forwarded for the following reasons. *(Please check appropriate box)*

☐ It was previously forwarded to DTIC on _____ *(date)* and the AD number is _____

☐ It will be published at a later date. Enter approximate date if known. _____

☐ In accordance with the provisions of DoD Directive 3200.12, the requested document is not supplied because: _____

Print or Type Name: Laura Peter

Signature:

Telephone: 210-536-4331

AD Number: M01-04-0621

Soil gas sampling results from Facility 6454 indicate that soil gas concentrations of TVH and all BTEX compounds increased in some and decreased in others. Soil samples collected after one year of bioventing were reduced by at least an order of magnitude to non-detect levels in BTEX concentrations. TRPH and the gasoline range TPH was not detected in MPA-30 and MPB-62 at both the initial sampling and after one year. TRPH concentrations remained steady at VW-15 between initial and one year sampling. However, TPH as gasoline analysis at VW-15 indicate a two orders of magnitude drop in concentrations between initial and one year samples.

Sample results indicate that a reduction in TRPH has taken place in the soils within the estimated vent well treatment radius of up to 50 feet at Facility 6454 and the 40 foot minimum radius at the BX Service Station. Due to the inherent variability of in-situ soils samples, TRPH sampling is inclusive at this time, but all other measurements indicate that fuel biodegradation is progressing at a significant rate.

Soil gas samples are similar to composite samples in that they are collected over a wider area. Thus, they provide a good indication of changes in soil gas profiles and volatile contaminant concentrations (see Addendum One to Test Plan and Technical Protocol for a Field Treatability Test for Bioventing - Using Soil Gas Surveys to Determine Bioventing Feasibility and Natural Attenuation Potential, February 1994). Soil samples, on the other hand, are discrete point samples subject to large variabilities over small distances and/or soil types. Given this variability, coupled with known sampling and analytical variabilities, a large number of samples would have to be collected to conclusively determine "real" changes in soils contamination. Because of the limited number of samples, these results should not be viewed as conclusive indicators of bioventing progress or evidence of the success or failure of this technology. In-situ respiration tests are considered to be better indicators of hydrocarbon remediation than limited soil sampling.

Data from your base and many others indicate that BTEX compounds are preferentially biodegraded over TRPH. Since BTEX compounds represent the most toxic and mobile fuel constituents, a BTEX standard is a risk-based standard. We strongly encourage its use over an arbitrary TRPH standard. Within the AFCEE Risk-Based Petroleum Hydrocarbon "Tool Box," the report entitled "Using Risk-Based Standards will Shorten Cleanup Time at Petroleum Contaminated Site" summarizes the BTEX/TRPH issue and will assist you in negotiating for a BTEX cleanup standard. Our information indicates that California requires remediation to TRPH clean-up levels, but this decision is made in conjunction with the results from a risk evaluation on a site-by-site basis. In conclusion, a risk-based approach will expedite site closure while reducing overall costs.

In general, quantitative destruction of BTEX will occur over a one-to two-year bioventing period. Soil gas surveys and respiration tests can be used as BTEX destruction indicators. If a non-risk-based/TRPH cleanup is chosen, the pilot and full-scale systems should be operated until respiration rates approach background rates. We recommend that confirmatory soil sampling be conducted four to six months after background respiration rates are approached.

Because these are streamlined test and evaluation projects, our contract does not provide for additional reports to the base on pilot study results. The interim results reports dated April 1993 for the BX Service Station and June 1994 for Facility 6454 contain as-builts and initial data. This letter summarizes all data collected and provides the next step recommendations. AFCEE recommends that the bioventing pilot systems continue to operate at both sites until background respiration rates are approached. We have initiated a contract to accompligh a full scale expansion of the Facility 6454 System and monitor this site for one year. Monitoring will include soil gas and respiration tests to document hydrocarbon degradation. If you have any questions, please contact Mr Sam A. Taffinder, AFCEE/ERT, DSN 240-4366, COM 210-536-4366, to discuss the technical details for full-scale expansion.

AFCEE is no longer responsible for the operation, maintenance, or monitoring of the bioventing system at the BX Gas Station. The blower and accessories are now base property and should continue to be used on this or other bioventing sites. Although current equipment is explosion proof, under no circumstances should it be used for soil vapor extraction unless appropriate explosion-proof wiring is provided. If the base does not want to keep the blower, or if you have further questions, please contact Mr. Taffinder.

On behalf of the AFCEE/ERT staff, I would like to thank you for your support of these bioventing test and evaluation projects. The information gained from each site will be invaluable in evaluating this technology and will promote its successful application on other DOD, Government, and private sites. I have attached a customer satisfaction survey. Please take a few minutes to fill it out and tell us how we did. We look forward to hearing from you.

Sam A. Taffinder

for MARTY M. FAILE, GM-14
Chief, Technology Transfer Division

3 Attachments:
1. BX Service Station Data
2. Facility 6454 Data
3. Survey

cc: HQ ACC/CEVR
AFCEE/ERD (Mr. McMindes)
HQ USAF/CEVR
Parsons Engineering Science (Mr. Downey)

TABLE 1
BASE SERVICE STATION
RESPIRATION AND DEGRADATION RATES
VANDENBERG AFB, CALIFORNIA

Location-Depth (feet below ground surface)	Initial			6-Month [b/]			1-Year		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
VA1-VEW1	NS [c/]	NS	NS	NS	NS	NS	0.0011	150	NS
VA1-VEW2	NS	NS	NS	0.0015	290	NS	0.0014	190	NS
VA1-VEW3	NS	NS	NS	0.014	2700	NS	0.0013	180	NS
VA1-VEW4	NS	NS	NS	0.00046	88	NS	0.00036	49	NS
VA1-VEW5	NS	NS	NS	0.00097	190	NS	0.00049	67	NS
BXS-MW-1	NS	NS	NS	0.0027	520	NS	NS [c/]	NS [c/]	NS
BXS-MW-5	0.0038[d/]	1000	NS	NS	NS	NS	0.0021	290	NS
BXS-MW-6	NS	NS	NS	0.000015	3	NS	NS	NS	NS
BXS-MW-7	0.0029[d/]	790	NS	0.00019	36	NS	0.00031	42	NS
VA1-MPB	NS	NS	23.7	0.00039	75	23.6	NS[c/]	NS [c/]	17.6
VA1-MPD-6	0.0022[d/]	580	NS	NS	NS	NS	NS [c/]	NS [c/]	NS
BXS-MW-12	NS	NS	NS	0.0039	750	NS	NS [c/]	NS [c/]	NS

[a/] Milligrams of hydrocarbons per kilogram of soil per year.

[b/] Assumes moisture content of the soil is average of initial and final moistures.

[c/] NS = Not sampled.

[d/] Reported initial oxygen utilization rates and biodegradation rates have been corrected for diffusion and therefore are lower than measured rates. The corrected rates were also reported in the Interim Test Results Report.

[e/] Monitoring point under water at 12-month testing.

1/fcl 1

TABLE 2
BASE SERVICE STATION
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
VANDENBERG AFB, CALIFORNIA

Analyte (Units) [a/]	Sample Locations-Depth (feet below ground surface)					
	VA1-MPD-6		VA1-BXS-MW-7		VA1-VW1	
Soil Gas Hydrocarbons	Initial [b/]	1-Year [c/]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	11,000	NS [d/e/]	45,000	2.0	2200	NS [e/]
Benzene (ppmv)	68	NS	400	< 0.002	12	NS
Toluene (ppmv)	190	NS	61	0.008	2.6	NS
Ethylbenzene (ppmv)	21	NS	60	0.006	3.5	NS
Xylenes (ppmv)	160	NS	240	0.038	17	NS
	VA1-MPD-5'-8'		VA1-MPB-6		VA1-MPC-6	
Soil Hydrocarbons	Initial [f/]	1-Year [g/]	Initial	1-Year	Initial	1-Year
TPH (gasoline)	NA [h/]	< 5	NA	< 5	NA	< 5
TRPH (mg/kg)	110	< 9.89	170	13.3	410	17.2
Benzene (mg/kg)	< 0.25	< 0.050	< 0.13	< 0.050	< 0.52	< 0.050
Toluene (mg/kg)	9.5	< 0.050	1.8	< 0.050	4.9	0.140
Ethylbenzene (mg/kg)	6.2	< 0.050	2.7	< 0.050	5.7	0.170
Xylenes (mg/kg)	46	< 0.130	22	< 0.130	69	1.9
Moisture (%)	5.0	14.4	7.2	11.7	7.7	12.3

[a/] TVH=total volatile hydrocarbons: ppmv = parts per million, volume per volume;
TPH (gasoline)=total petroleum hydrocarbons as gasoline;
TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram.

[b/] Initial soil gas samples collected on September 12, 1992.

[c/] Final soil gas samples collected on May 7,1995. Blower system was shut down approximately 30 days prior to soil gas sampling to allow soil gas to come to equilibrium with soils.

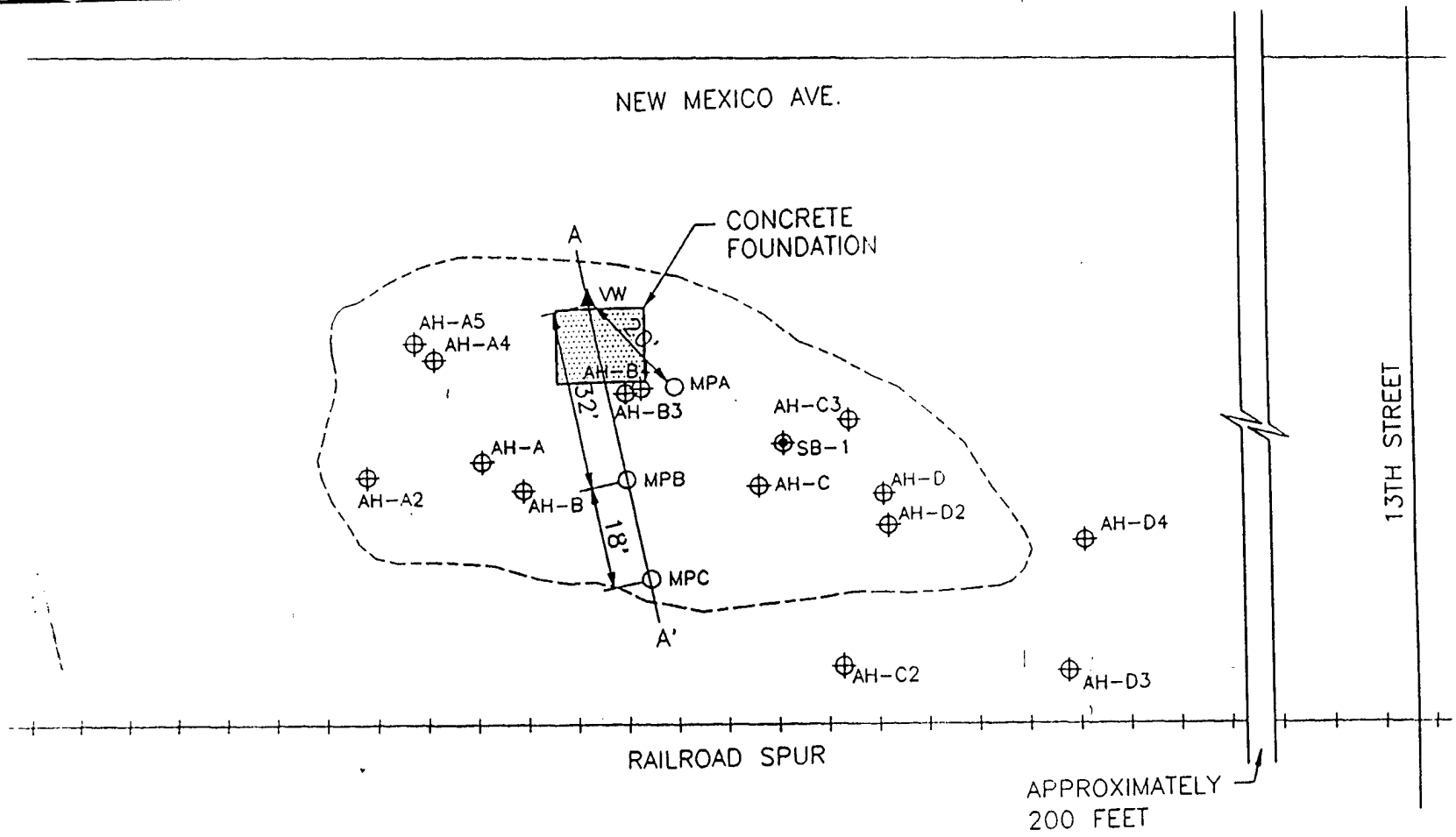
[d/] NS = Not sampled.

[e/] Monitoring point was under water and therefore not available for sampling at the 1-year test.

[f/] Initial soil samples collected on September 10, 1992.

[g/] Final soil samples collected on May 22, 1995.

[h/] NA = Not analyzed.



LEGEND

- APPROXIMATE EXTENT OF TPH CONTAMINATION ABOVE 10 mg/kg
- ⊕ APPROXIMATE LOCATION OF EXISTING BORING
- ▲ VENT WELL
- ○ MONITORING POINT
- ⊕ NEW SOIL BORING

0 15' 30'
SCALE

SOURCE: BUREAU OF RECLAMATION SITE SKETCH

FIGURE 1

AS-BUILT VENT WELL AND VAPOR MONITORING POINT LOCATIONS

SITE 6454
FORMER FUEL TRANSFER FACILITY
Vandenberg AFB, California

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

1142

TABLE 1
SITE 6454
RESPIRATION AND DEGRADATION RATES
VANDENBERG AFB, CALIFORNIA

Location-Depth (feet below ground surface)	Initial			6-Month [b/]			1-Year		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
VA2-MPA-10	0.00068	70	16.2	0.00084	93	20.8	0.0018	220	16.1
VA2-MPA-40	0.0021	490	NS [c/]	NC [d/]	NC	NS	NC	NC	NS
VA2-MPA-60	NS	NS	18.7	NC	NC	19.5	NS	NS	19.0
VA2-MPB-10	NS	NS	NS	0.0036	400	NS	0.0037	450	NS
VA2-MPB-20	0.00040	50	NS	0.00065	78	NS	0.00094	100	NS
VA2-MPB-50	0.0019	490	NS	NC	NC	NS	0.0034	760	NS
VA2-MPC-20	NS	NS	NS	0.0012	150	NS	NS	NS	NS
VA2-MPC-30	0.0014	130	NS	NC	NC	NS	0.00079	30	NS
VA2-MPC-40	NS	NS	NS	NC	NC	NS	0.0064	640	NS
VA2-MPC-50	NS	NS	NS	NC	NC	NS	.0022	490	NS
VA2-MPC-60	0.0021	540	NS	NC	NC	NS	0.00052	120	NS
VA2-VW	NS	NS	NS	NC	NC	NS	0.0026	360	NS

[a/] Milligrams of hydrocarbons per kilogram of soil per year.

[b/] Assumes moisture content of the soil is average of initial and final moistures.

[c/] NS = Not sampled.

[d/] NC = Not calculated. Oxygen concentrations failed to show significant reduction during testing.

TABLE 2
SITE 6454
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
VANDENBERG AFB, CALIFORNIA

Analyte (Units) [a]	Sample Locations-Depth (feet below ground surface)					
	VA2-MPB-20		VA2-MPC-10		VA2-MPC-60	
Soil Gas Hydrocarbons	Initial [b]	1-Year [c]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	190,000	100,000	7,200	28,000	120,000	12,000
Benzene (ppmv)	280	370	9.2	25	33	74
Toluene (ppmv)	300	210	19	< 2.2	39	41
Ethylbenzene (ppmv)	33	54	11	38	5.0	23
Xylenes (ppmv)	74	110	20	35	5.9	52
	VA2-VW-15		VA2-MPA-30		VA2-MPB-62	
Soil Hydrocarbons	Initial [d]	1-Year [e]	Initial	1-Year	Initial	1-Year
TPH (gasoline)	960	< 5	< 1.2	< 5	< 1.2	< 5
TRPH (mg/kg)	13 [f]	14.2	< 5.6	< 9.98	< 5.6	< 10
Benzene (mg/kg)	1.2	< 0.050	0.067	< 0.050	0.048	< 0.050
Toluene (mg/kg)	6	< 0.050	0.028	< 0.050	0.062	< 0.050
Ethylbenzene (mg/kg)	5.5	< 0.050	0.0036	< 0.050	0.007	< 0.050
Xylenes (mg/kg)	19	< 0.130	0.021	< 0.130	0.036	< 0.130
Moisture (%)	14.0	12.9	12.7	15.3	12.7	13.0

[a] TVH=total volatile hydrocarbons: ppmv = parts per million, volume per volume;
TPH (gasoline)=total petroleum hydrocarbons as gasoline;
TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram.

[b] Initial soil gas samples collected on Febuary 28, 1994.

[c] Final soil gas samples collected on March 6,1995. Blower system was shut down approximately 30 days prior to soil gas sampling to allow soil gas to come to equilibrium with soils.

[d] Initial soil samples collected on February 22-24,1994.

[e] Final soil samples collected on May 22, 1995.

[f] Initial TRPH is corrected from Interim Test Results.